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ABSTRACT

This instructional unit is one of 10 developed by students on various energy-related areas that deals specifically with lighting utilization. Its objective is for the student to be able to outline the development of lighting use and conservation and identify major types and operating characteristics of lamps used in electric lighting. Some topics covered are natural and artificial light, two major kinds of electric light bulbs, and light conservation when designing, building, and living in a home. Material in each unit may include some or all of the following: terminal and specific objectives, list of references, information sheet with terms and definitions, informative materials, transparency masters, assignment sheet(s), and unit test with answers. (YLB)

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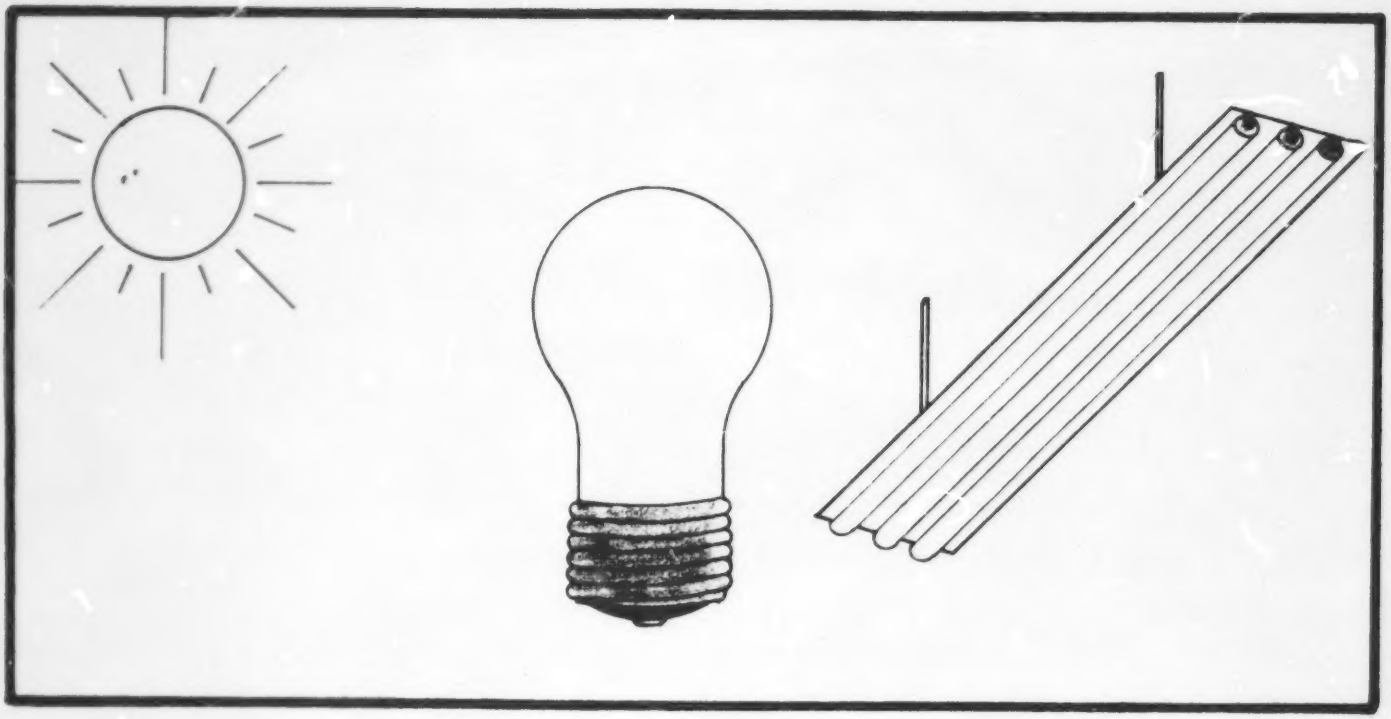
LIGHTING UTILIZATION



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LIGHTING UTILIZATION

TERMINAL OBJECTIVE

Upon completion of this unit the student will be able to outline the development of lighting use and conservation. The student will be able to identify the major types and operating characteristics of lamps used in electric lighting. Proficiency will be evidenced by completion of the unit test with at least 85% accuracy.

SPECIFIC OBJECTIVES

After completion, the student will be able to:

1. Indentify factual general information concerning lighting use from non-factual information.
2. Define and explain the workings of the two major kinds of electric lamps.
3. Discuss steps related to light conservation when designing and building a home.
4. Explain the historical development of mankind's use of lighting from early days to the nineteenth century.
5. Identify terminology related to lighting utilization from selected group of definitions.
6. Explain steps that a present owner of a structure can utilize to conserve lighting.

LIGHTING UTILIZATION

INFORMATION SHEET

I. Terms and Definitions

A. Ballast -- a circuit that controls the rate of flow of electric current through a fluorescent lamp.

B. Fluorescence -- light resulting from the action of ultraviolet or other forms of radiant energy on phosphorus.

C. Footcandle -- unit of illumination, one footcandle is one lumen per square foot.

D. Incandescense -- light emission by a heated filament or coil.

E. Kilowatt -- 1000 watts

F. Kilowatt Hour -- unit of electricity usage equal to 1000 watts of electrical energy consumed for an hour.

G. Lumen -- amount of light spread over a square foot of surface by one international candle from a distance of one foot.

II. References:

A. Christiansen, Beth, Consumer Use of Energy, Kansas Vocational Curriculum Dissemination Center, Pittsburg, KS 1978.

B. New Energy Saving Light Bulb, ERDA Administration, Office of Public Affairs, Washington, D.C. 1976.

C. 104 Ways To Control Your Electric Bill, Edison Electric Institute for the Electric Companies, New York, 1976.

LIGHTING UTILIZATION

The United States has become a nation of abundant lighting. Cities as bright as in the daytime, floodlit homes with light streaming from every window, and bright flashing lights are used to attract our attention to everything from fast food joints to major shopping centers.

Light is an essential part of our lives. It has extended day into night and is an important decorating tool. Light provides safety against the fear of darkness and makes our streets and homes secure.

The situation was not always like we know today. For many thousands of years mankind's only light was from fires built for heat and cooking. It was about two thousand years ago that the candle was first used as a source of light. Some historians say that the Chinese utilized natural gas as a scurce of light by burning that which excaped from the ground. This is not unusual because many of our rural residents burned excess natural gas in the midwest instead of sealing off wells for further usage. The emergence of manufactured gases for lighting did not occur until the late nineteenth century. The era of electric lighting began with the invention of the filament bulb by Thomas A. Edison in 1870.

Our lighting habits have grown from the early days far exceeding our actual needs. In the use of lighting we have become a nation of over consumers and have taken for granted the availability of radiant energy at just the flick of a switch or turn of a dial.

Home lighting accounts for about 5% of the total electric

energy load in the United States. Lighting in the home requires a wide variety of brightness degrees and levels of light for people of different ages. The amount needed in the workshop or sewing area is not the same as general living areas. In business we can separate the lighting areas into specialized areas of factory or office to satisfy lighting levels. At home the needs are diverse and the planning and actionare required to bring conservation to lighting utilization.

We are concerned with the use of two main sources of illumination, artificial and natural. First, let us explore the use of daylight.

The proper use of natural light, whether it be in designing a new structure or properly utilized in an existing one, should first be considered. The location of the structure in relation to the sun's radiation is important to maximum light availability. Light directing techniques in design are important to obtaining the most possible natural light -- adequate and large windows with proper size, shape, and exposure to the sunlight. Other sources of light are through skylights and glass block and prismatic clear materials.

The design of the structures to use optimum light also requires methods to reduce lighting during periods of heat and high cooling needs. The proper use of outside louvers, roof overhangs, baffles, exterior screening on new structures and awnings, landscaping, roller shades, blinds and drapes on existing homes to regulate the sun's rays.

The use of light from natural sources for lighting has a double benefit. The radiant rays generated through windows and skylights when emitting light is also a form of heat energy. This type of energy is called passive solar and is a method of free energy. This

reason is the best, to incorporate natural light into a home, it does not cost anything to use.

The best advantages of natural light inside the home can be made by decorating with light colors on walls and furnishings that enhance lighting. The use of reflective surfaces on both interior and exterior portions of the home can aid in the amount of available light.

The second source of light is man made artificial method that started with the fire and progressed up to the vast array of lamps in use today.

Lighting serves all kinds of useful and not so utilitary reasons in its use. Much has been written and said about sign blight and the apparent waste of the resources with impressive light usage. We should not let the overuse of the electric light in commerce and industry for merchandising reasons cause us to think less about the need to conserve in our own lighting use.

There are two broad classifications of electric light bulbs. The tungsten filament type and the gaseous discharge group. We know the first type as the common light bulb that comes in many sizes and is also known as an incandescent lamp. The latter group includes mercury vapor, neon, sodium and the very popular fluorescent.

Incandescent lamps produce light as a result of the heating effect of electric current flowing through a filament wire. Tungsten is particularly suitable on account of its high melting point.

Fluorescent type lamps work from the action of ultraviolet or other forms of radiant energy reacting on the phosphorus coating of the lamp interior. The fluorescent lamp has proved to be the most

successful and widely used of the gaseous discharge type lamp. The manufacturing process lends itself very well to the production of fluorescent bulbs and therefore they are somewhat inexpensive in relation to their benefits.

Lighting use is generally valued by the following characteristics. Optimum lighting for the conditions that prevail - quantity of light desirable and the brightness of the lamp. Uses of lights can be divided into two classifications of tasks: Those that are with the head down or with the head of the person up. Because of the nature of these tasks, the light intensity would vary from very bright to somewhat less bright.

It has been discovered that lighting levels were increased in many school buildings from twenty-foot candles to over sixty foot candles in the early seventies. This was an increase of over 200% in less than twenty years. Studies have since proved that a light level of less than ten foot candles is adequate for efficient reading. In fact, higher light levels may increase fatigue from glare and excessive brightness.

Electric lighting is used basically for the following reasons: Utilized to provide light for efficient seeing and to allow for comfort, the effect that illumination can add to achieving beauty, the creation of a safe and secure situation by illumination, and lastly, lighting should be flexible to meet a wide variety of situations.

The conservation of energy in the use of lighting is at this point somewhat obvious and in some ways not so evident. It is obvious that the natural lighting techniques discussed would make the need for artificial lighting in lesser degrees as the natural light is made more useful.

A very inefficient method of lighting is the practice of using incandescent bulbs which are inefficient compared to fluorescent. Energy needs could be reduced by 70% by replacing incandescent with fluorescent lighting. Fluorescent lights produce three times the light with the same amount of electricity. However, the cost of replacing incandescent fixtures with new ones to hold currently bulky fluorescent tubes inhibits the switch to the more efficient lighting.

The belief that there is a surge of electricity when lights are turned on is not true. Therefore, it is not better to leave lights on rather than turn them on and off.

Because of the different method of working incandescent bulbs are less energy efficient. Only about 10% of the energy input becomes visible light, the balance is wasted heat. The light comes from the filament heating to a high temperature by electricity flowing through it.

The fluorescent unit emits visable light but very little heat and therefore is more efficient in the use of electricity. The electrons emitted by electrode in conventional fluorescent light excite atoms producing ultraviolet light. The visible light of the bulb comes from the ultraviolet light causing phosphorus layers inside the tube to give off light.

There is an experimental electrodeless fluorescent light being tested and refined for development and readied for marketing. The unit looks like a conventional bulb. It fits the standard incandescent fixture. This means they can be replaced for greater efficiency without the cost of fixture replacement. They contain no electrodes or filaments to burn out and may provide efficient and

inexpensive lighting for several years. The cost provisions of the new bulb could be over five dollars but volume production would be expected to bring that down. Replacement cost and the reduced operating cost mean substantial savings. The projection of the innovation is to produce three times as much light per unit of electricity. This means the user will receive lower operating cost as a benefit. There is a 20,000 hour operating lifetime where conventional bulbs last only about 750 hours.

There are many other methods to conserve lighting. Turning off lights upon leaving a room which is encouraged more easily when every area has its own wall switch (three-way switches for spaces having two entry ways).

Task lighting over desk, benches, sewing tables so that work and leisure activities can be carried on without illuminating the entire room.

Reflectance of interior surfaces have important bearing on lighting efficiency. Choose lighter colored walls, ceilings, floors and furniture. Use of dark colors absorb light and require higher lamp wattage for given level of illumination. Light colored surfaces kept clean to keep reflectance near like new value helps illumination. Using a single large bulb, rather than filling all sockets of fixtures with bulbs of a smaller wattage will require less energy.

Ratings of all incandescent light bulbs in the house should be checked to see if lower wattage bulbs may be substituted for the one now being used. "Long life" bulbs emit less light than standard incandescent bulbs of the same wattage but last longer. This is the reason that they are advantageous in places that are hard to reach.

Floor, table, and hanging lamps should be located in the corner of the room rather than flat against one wall. This causes light to be reflected off two surfaces instead of one, giving more useable light.

Lighting fixtures should be cleaned regularly. Dust accumulates on lamps and reflectors, therefore, impairing lighting efficiency.

In large areas such as family rooms or recreation areas where high levels of lighting are periodically required, install fixtures on serveral circuits. Then illumination can be controlled by switching circuits on and off.

When purchasing light bulbs be aware of the wattage ratings. Identify only the amount of power necessary to make the bulb work for the particular situation. Also, note the brightness as measured in lumens. Larger wattage bulbs usually are more efficient producing more lumens per watt than smaller bulbs.

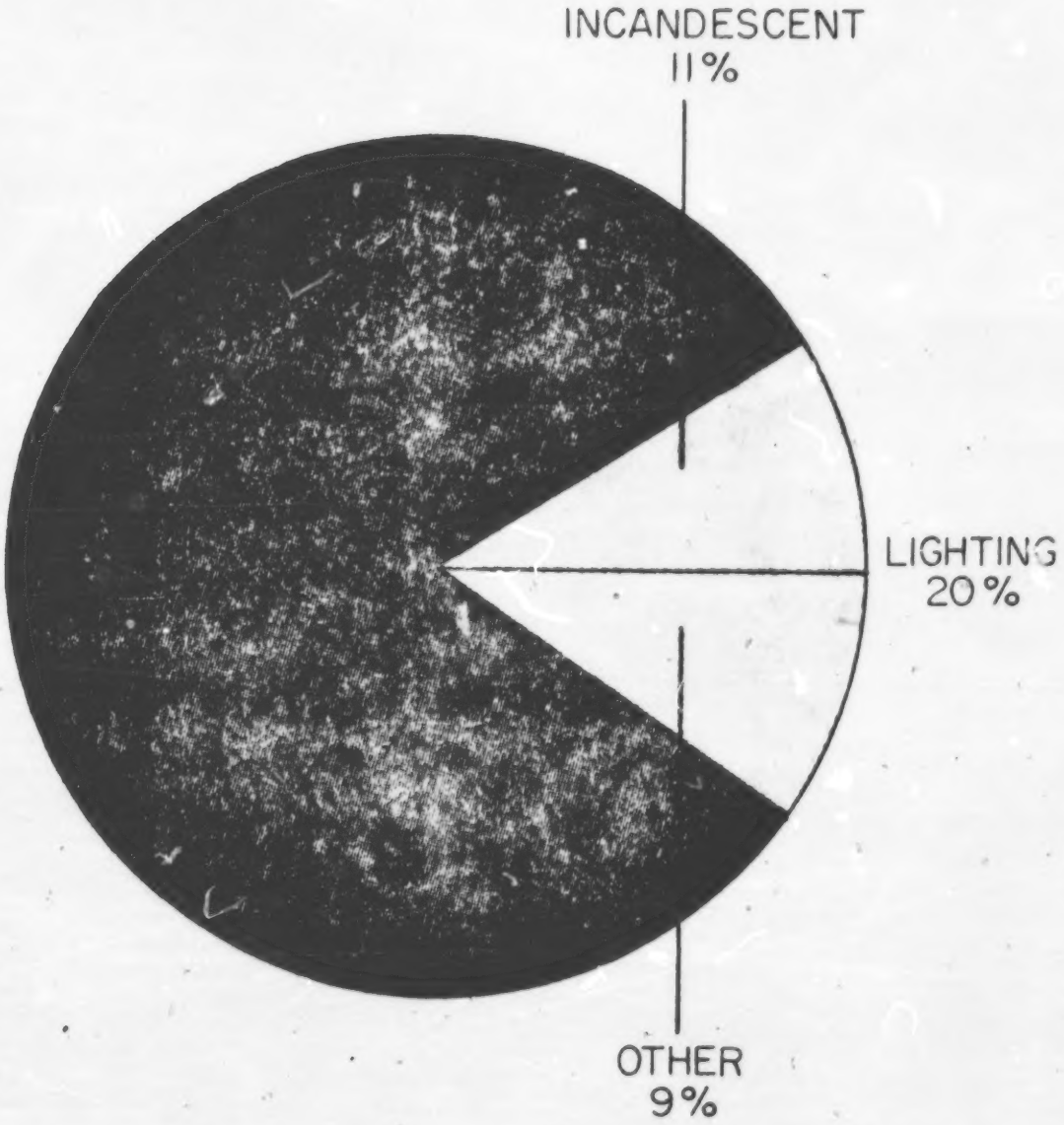
Outdoor lighting needs also should be considered for energy saving measures. Consider replacing incandescent lights in outdoor lighting fixtures with sodium vapor lights now available for residential applications. Sodium vapor type lighting is another gaseous category lamp like fluorescence with a greater efficiency. They are also longer life and would be less likely to require replacement in difficult locations and weather conditions.

To insure that outdoor lighting is turned off during the daytime install photo electric controls or a timer.

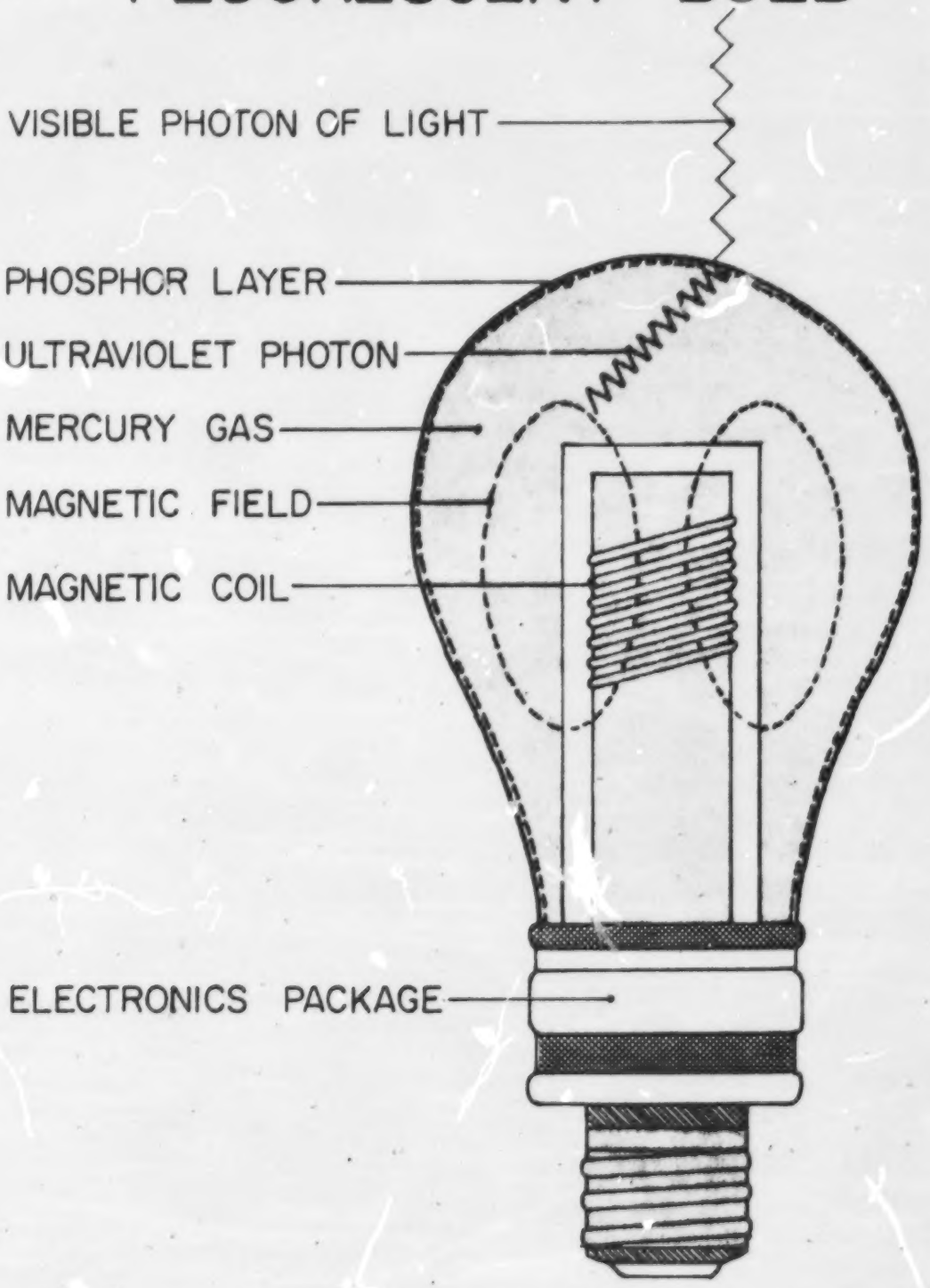
The facts and suggestions mentioned here are to help you be aware of and look for ways to make every watt count. Remember newer wattage light bulbs use less electricity for the same amount of light

output. Outmoded lighting equipment and unclean fixtures consume more energy and cost more money. Remember to use lights for specific work areas instead of lighting up the whole entire room area. Always purchase the proper size bulbs for lamps and fixtures. Turn off the lights when not in use. Use dimmer switches and three-way bulbs whenever possible. Decorate with light-colored paint or wallpaper and take advantage of natural light. When you will be away from home and prefer to leave lights on, use timers or photo cells to regulate interior and outdoor security lighting.

UNITED STATES ELECTRIC ENERGY



ELECTRODELESS FLUORESCENT BULB



LIGHTING UTILIZATION

ASSIGNMENT SHEET #1

Energy Labeling of Appliances Using Electricity

Current trends toward consumer awareness of energy expenditure/cost of operating have led manufacturers to begin putting this information on appliances.

1. Check all appliances that utilize electricity within your home. List those which do have energy-consciousness labeling.

2. What information is given there?

3. If no home appliances contain this information go to an appliance dealer for it.

4. From a consumer's point of view what additional value does energy usage information labeling have?

5. Who is responsible for this increased awareness information being made available to the consumer?

6. What percentage of the appliances in your home fall under the classification of "nice to have, but not essential"?

7. What conclusions can you draw about the amount of time invested in use of appliances?

8. Suppose, someday in the future, energy in the form of home electricity were to be rationed - if it were absolutely necessary to eliminate some appliances in order to conserve even a small amount of energy, which of the ones that you listed could you eliminate or find some other means of achieving the same goals for? List those below.

9. Which are absolutely essential? List them below.

10. What rationale did you use for each of the choices? Explain your answers.

11. Are the actual dollar costs of operating any of the appliances more or less than you expected? Which?

12. What other energy costs can be applied to the appliances in your home? Explain your answer.

LIGHTING UTILIZATION

ASSIGNMENT SHEET #2

Operating Costs of Electrical Appliances

Energy used by appliances is widely believed to be responsible for increased usage of energy in recent years. Research does not substantiate this theory. However, it is useful for the consumer to know the actual amount of energy expended in the operation of electrical devices.

In the space below enter the information requested and actually compare the costs of operating your own personal home appliances. (Use 4.5¢ as a rate of cost per kilowatt hour. List all appliances in your home.

Name of appliance	Energy needed to operate/ kwh	Amount of time used monthly	Cost of Operation		Evaluation of Appliance*		
			Monthly	Yearly	E	U	N

* E= essential / U= useful / N= nice to have, but not essential

LIGHTING UTILIZATION

ASSIGNMENT SHEET
#3

Demonstrate the relative energy efficiency of fluorescent and incandescent lighting. Wattage is not a measure of the amount of light given off by a light bulb, but how much energy is required to operate it. The amount of light it provides is indicated in lumens. Bulb packages should give not only the wattage required, but also the lumens produced by the bulb. Using bulb packages, compare several incandescent and fluorescent bulbs for efficiency (lumens per watt).

For example: A 100-watt incandescent bulb may yield 1750 lumens which gives the bulb an efficiency of 17.5 lumens per watt:

$$\frac{1750 \text{ lumens}}{100 \text{ watts}} = 17.5 \text{ lumens per watt}$$

Determine the efficiency of the following bulbs, plus any others you may have.

A. 100 watt fluorescent bulb: $\frac{\text{____ lumens}}{100 \text{ watts}}$ = _____ lumens per watt

B. 40 watt fluorescent bulb: $\frac{\text{____ lumens}}{40 \text{ watts}}$ = _____ lumens per watt

C. 100 watt incandescent bulb: $\frac{\text{____ lumens}}{100 \text{ watts}}$ = _____ lumens per watt

D. 25 watt incandescent bulb: $\frac{\text{____ lumens}}{25 \text{ watts}}$ = _____ lumens per watt

1. Which type of lighting is more efficent - incandescent or fluorescent?

2. Is it more efficient to buy four 25-watt or one-100 watt incandescent bulb?

Suggestions:

1. Ask the school maintenance supervisor for empty fluorescent light bulb boxes. The information you need is on the box, not the bulb.

2. Have students bring in bulb boxes from home.

3. Check at home for the use of multiple low wattage bulbs where a larger wattage bulb might be used to save energy. But remember,

a larger wattage bulb gets hotter during operation and some fixtures are not designed for the larger wattage bulb.

4. Discuss the comparative lifetimes of fluorescent and incandescent bulbs.

5. Discuss the turning off and on of incandescent and fluorescent bulbs.

LIGHTING UTILIZATION

TEST

I. Indicate the correct response to each statement by circling "T" for true and "F" for false in the statements below.

T F 1. One major objective of energy conscious design in housing is to gain maximum control over the interior environment.

T F 2. Windows are a major source of heat loss and heat gain in structures.

T F 3. Lighting within structures utilize about 20 percent of electric energy generated in United States.

T F 4. Incandescent light bulbs are more energy efficient than fluorescent light bulbs.

T F 5. There is usually a surge of power when lights are turned on, so it is better to leave lights on rather than turning them off and on.

T F 6. Cost of replacing incandescent light fixtures with fluorescent bulbs is an important factor preventing change.

T F 7. Projected cost per unit of experimental electrodeless fluorescent lights make them prohibitive to the average consumer.

T F 8. Average life expectancy of conventional incandescent light bulbs is about 750 hours.

T F 9. "Task lighting" can significantly reduce amount of light needed to illuminate area.

T F 10. Dark colors reflect light, therefore, they require less lamp wattage for a given level of illumination.

T F 11. "Long-life" light bulbs actually emit less light than standard incandescent bulbs of same wattage.

T F 12. Lamps placed in corners reflect more light than do those placed against a flat wall.

T F 13. Dust on lamps and reflectors impair lighting efficiency.

T F 14. Larger wattage bulbs usually are more efficient than smaller bulbs.

T F 15. Brightness of a light bulb is measured in wattage.

T F 16. Sodium vapor lights consume more energy than incandescent lights.

T F 17. Photo electric controls can be installed on outdoor lights to turn them on when nighttime falls.

LIGHTING UTILIZATION

ANSWER SHEET

I. 1. T
2. T
3. F
4. F
5. T
6. F
7. F
8. T
9. T
10. F
11. T
12. T
13. T
14. T
15. F
16. F
17. T